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AQUATIC MACROINVERTEBRATES

WITHIN THE PHOSPHATE MINING AREA OF EASTERN IDAHO

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ABSTRACT

The composition and diversity of benthic macroinvertebrates in the upper Blackfoot River drainage were recorded during the summer and fall of 1973, 1974, and 1976 to provide data for future assessment of mining impact. Basket samplers filled with natural substrate were placed at randomly selected stations. Analyses revealed the number of taxa, many of which were widely distributed, to be large (84). Mayflies of the genus Baetis *and the midge family, Chironomidae, were the dominant forms. Shannon-Weaver heterogeneity indices for all stations ranged from 2.6 to 4.3, with most stations having 3.1 or higher. The benthic taxa of the upper Blackfoot River and its tributaries compare favorably with those of several unpolluted streams of southeastern Idaho. Several stations had large standing crop changes, but the causes of these changes are unknown.*

KEYWORDS: benthos, macroinvertebrates, fish, water quality, species diversity, surface mining, phosphate

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INTRODUCTION

In 1977, 83 phosphate mining leases covered 43,370 acres (17 551 ha) of federal lands in southeastern Idaho. The U.S. Department of the Interior, Bureau of Land Management and the USDA Forest Service have pending applications for additional mining leases. Lease approvals will result in applications for permits to build roads, conveyor systems, railroads, powerlines, dump sites, and communication sites.

A majority of the mine leases and potential mining sites are located on or near tributary streams of the upper Blackfoot River. Previous open pit mining operations in the study area have caused sediment and petroleum pollutants to enter Angus Creek (Platts 1970), a Blackfoot River tributary. Since this polluting period, the mining corporation has better contained mine-caused pollutants.

If the leases pending are approved, prospecting and mining will disrupt headwater streams in the Blackfoot drainage. As an example, the area proposed for mining in the Angus Creek watershed is 315 acres (127.5 ha)--129 acres (52.2 ha) in mine pits, 85 acres (34.4 ha) in waste dumps, 89 acres (36.0 ha) in roads, and 12 acres (4.9 ha) of water control structures. Mining operations of this magnitude could have adverse influences on Angus Creek.

At present, the full impact of surface mining on the biota is difficult to detect or quantify because of financial and methodological limitations. Some streams have already been influenced by surface mining, but data to evaluate the environmental consequences are scarce. This report, along with reports on fish population dynamics, hydrochemistry, macroinvertebrate-fish population relationships, and aquatic structural conditions, will provide these data and furnish a basis for evaluating any future changes in the drainage. With the acceleration of surface phosphate mining throughout southeastern Idaho, sediment will eventually increase in the streams and throughout most of the upper Blackfoot system (USDA Forest Service 1976), probably with detrimental effects on aquatic life in the Blackfoot system (USDA Forest Service 1976).

The aquatic environment and biota of the Blackfoot River drainage, including macroinvertebrates, were investigated from 1970 through 1976 to provide information for future assessment of mining impact on the drainage. Other reports discuss the relationship of fishery,[3] stream geomorphology, riparian environments,[4] and hydrochemistry (Platts and Martin 1978) to environmental conditions.

STUDY AREA DESCRIPTION

The study area is located in Caribou County, Idaho (fig. 1). The study streams are in the Blackfoot River drainage, the major drainage in the Caribou National Forest. These streams drain watersheds encompassing past, present, and proposed phosphate mining sites. The proposed sites could continue to detrimentally affect the stream environments (Platts 1975).

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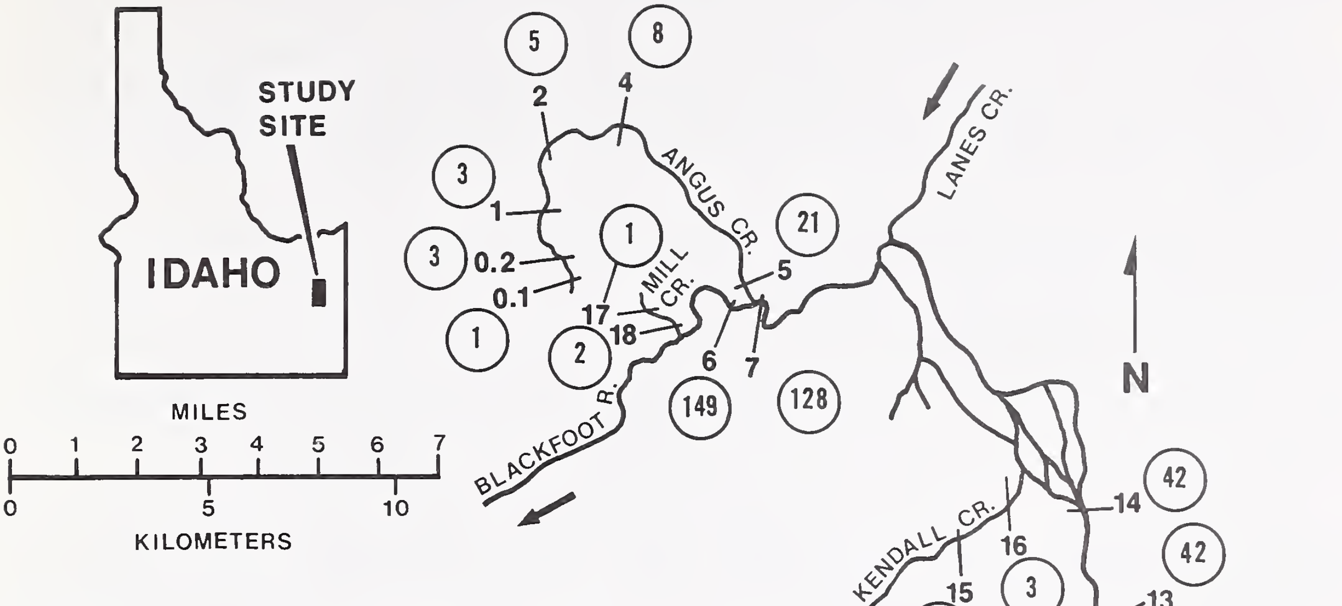
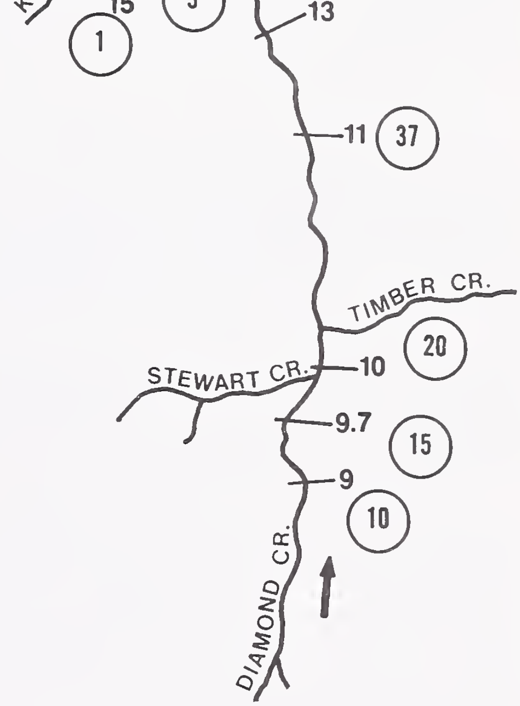
[3]Platts, William S., and Edwin Buettner. Fish populations within the phosphate mining area of eastern Idaho. USDA For. Serv., Intermt. For. and Range Exp. Stn., Ogden, Utah. (In preparation.)

[4]Platts, William S., and Fred E. Partridge. Aquatic geomorphic - riparian conditions within the phosphate mining area of eastern Idaho. USDA For. Serv. Intermt. For. and Range Exp. Stn., Ogden, Utah. (In preparation.)





STATION KEY

SITE NUMBER	NAME	STREAM ORDER
0.1	SPRING	1
0.2	UPPER RESERVOIR	2
1	LONE TREE	2
2	CORNER HILL	3
4	BELOW NARROWS	3
5	LOWER ANGUS	3
6	LOWER BLACKFOOT	5
7	UPPER BLACKFOOT	5
9	DUGWAY	3
9.7	LOWER DUGWAY	3
10	STEWART	3
11	BEAR	4
13	CAMPBELL	4
14	CARIBOU FOREST BOUNDARY	4
15	UPPER KENDALL	1
16	LOWER KENDALL	2
17	UPPER MILL	1
18	LOWER MILL	2

Figure 1.--Study streams and locations of the benthic macroinvertebrate sampling stations. Stream orders and link numbers ⓝ of the stations are also given.

The location of the sampling stations on each stream; stream order, based on the classification of Leopold and others (1964); and the number of first order links[5] (Shreve 1966) above each station appear in figure 1.

Bedrock in the study unit is mainly Paleozoic and Mesozoic marine sediment composed of limestone, shale, sandstone, mudstone, and chert. The Phosphoria Formation is the principal source of phosphate mined in this region. These substrates, rich in nutrients and minerals, provide stream waters with the elements required for high aquatic biomass production.

The study streams are found mainly within the mountain valley bottomlands. The terrain is gently sloping. Streambanks often flood during spring and early summer and have a high vegetative productivity potential.

Mean annual precipitation varies from 20 to 30 inches (51 to 76 cm), mainly in the form of snow, and results in a mean annual runoff of 10 inches (25 cm). Hydrochemical data indicate the surface waters are very fertile and, when good physical habitat is present, large standing crops of fish can occur (Platts and Martin 1978).

Macroinvertebrate populations in the drainage may be affected by mining, logging, irrigation diversions, degraded irrigation return flows, and intensive streambank grazing by livestock.

STUDY STREAMS

Angus Creek

Angus Creek drains 13.9 mi^2 (36 km^2) of land ranging in elevation from 6,397 to 7,100 feet (1 950 to 2 165 m) and averaging 6,500 ft (1 980 m). Formed mostly in an alluvial valley, 92 percent of Angus Creek consists of low gradient channels in bottomlands; the remaining reach flows through a steep V-shaped canyon.

Although the base flow is mainly from springs, streamflow in Angus Creek changes radically because of snowmelt and in the headwaters because of stream diversions for mining purposes. Most of the streamside vegetation comprises grasses, willow, and sagebrush.

Angus Creek contains cutthroat trout (*Salmo clarki* Richardson), suckers (*Catostomus catostomus* Forester, *C. platyrhynchus* Cope), dace (*Richardsonius balteatus* Richardson), and sculpin (*Cottus* spp.). Angus Creek is an important spawning and rearing area for cutthroat trout (Thurow 1979). The fish population from station 4 upstream to within 800 yards (730 m) of the Angus Creek headwaters is dominated by cutthroat trout. The upper 800 yards (730 m) of water is barren of fish (1970-1976), except for a small, newly constructed reservoir where trout survival and growth have been excellent. In Angus Creek, from the narrows downstream to its mouth, the fish population is composed mainly of dace, redside shiner, and sculpin with lesser numbers of cutthroat trout.

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[5]A link number is the number of first-order streams upstream from a particular sampling station. The link number indicates the topological complexity of the stream network above any given site.

Angus Creek has a mean alkalinity of 150 mg/liter, hardness of 142 mg/liter, temperature of 7°C, dissolved oxygen concentration of 12 mg/liter, and pH ranging around 7.5 (Platts and Martin 1978). Phosphorus concentrations are high. Mean values for dissolved phosphate (orthophosphate) (0.11 mg/liter) exceeded levels which result in high biotic production in aquatic systems (0.01 mg/liter, McKee and Wolf 1971). These values exceeded the concentration of 0.05 mg/liter total phosphorus recommended as the maximum level that should be allowed in streams flowing into lakes (Federal Water Pollution Control Administration 1968). The high Angus Creek values for orthophosphate may be a natural condition due to the geological nature of the drainage.

The moderate concentrations of nitrogen compounds present (nitrate-nitrogen averaged 0.21 mg/liter) may have been a limiting factor to game fish. The ammonia levels present were below those known to be toxic to aquatic life (2.5 mg/liter, McKee and Wolf 1971). The turbidity in Angus Creek during spring runoff (11 nephelometric turbidity units [ntu]) is slightly higher than the recommended 10 ntu (Federal Water Pollution Control Administration 1968). This may be due to the high amount of particulate matter in Angus Creek, which in turn is reflected in its high fertility.

Blackfoot River

The Blackfoot River above the reservoir contains cutthroat trout, rainbow trout (*Salmo gairdneri* Richardson), sucker, dace, redside shiner, sculpin, brook trout (*Salvelinus fontinalis* [Mitchell]), and possibly brown trout (*Salmo trutta* Linnaeus). Cutthroat trout (some of trophy size) also migrate from the Blackfoot Reservoir to spawn in the river and tributary streams.

Hydrochemical values for the Blackfoot River were similar to Angus Creek. The turbidity, chemical oxygen demand, total organic carbon, and nitrate were, however, significantly lower than in Angus Creek. This may be due to the dilution factor of the larger stream, as well as to less development in the Blackfoot River watershed above Angus Creek. Total orthophosphates are higher than recommended limits (Federal Water Pollution Control Adminstration 1968; McKee and Wolf 1971).

Diamond Creek

Diamond Creek joins Lane's Creek to form the Blackfoot River. At present, there is little mining activity in the Diamond Creek area, except for exploration for minerals in the Stewart Creek drainage. Several mines have been proposed and will be located in this drainage in years to come.

Diamond Creek contains cutthroat trout, brook trout, sculpin, and possibly dace, redside shiner, and sucker. This stream is the primary tributary of the Blackfoot River for spawning and rearing of cutthroat trout. Beaver dam the stream and cut streamside vegetation and cattle graze on riparian vegetation, altering the banks. Irrigation diversion and stream splitting near its mouth often cause portions of Diamond Creek to dry up during summer and fall.

Diamond Creek hydrochemistry, in most cases, is comparable to that of Angus Creek and that of the Blackfoot River. Values for mean annual hardness, suspended sediment, chemical oxygen demand, and Kjeldahl nitrogen were higher than in Angus Creek and the Blackfoot River, while total dissolved solids and conductivity were less. All values, when considered individually, were well within the range for a good salmonid habitat. With a high mean dissolved phosphate concentration (0.11 mg/liter) and moderate nitrate level (0.15 mg/liter), Diamond Creek has the potential of being a highly productive system.

Kendall Creek

Kendall Creek once drained into Diamond Creek, but has been diverted into Spring Creek. Kendall Creek is 3 miles (4.8 km) long and has an average channel gradient of 6 percent in the upper half, which results in poor fish habitat in this reach. Below the Caribou Forest boundary, Kendall Creek flows onto the Diamond Creek valley and the stream gradient becomes much lower. The stream provides little spawning habitat for cutthroat trout. Mining and livestock grazing have occurred within the Kendall Creek watershed, but upstream from the Caribou National Forest boundary these uses have been light and so have had little impact.

Chemical values for Kendall Creek were less in all instances than for the streams previously discussed. The average dissolved phosphate concentration being less (0.04 mg/liter) would probably result in less primary production in this stream. The Kendall Creek chemical environment is suitable for salmonids, although it may support a lower fish density than other streams in the study area.

Mill Creek

Mill Creek drains part of the Wooley Range and should be distinguished from the Mill Creek that drains part of Dry Ridge. Mill Creek of the Wooley Range empties directly into the Blackfoot River. The stream is small, only 1.2 miles (3.4 km) in length and, with its 12 percent channel gradient, has little fishery value. The average stream flow is only 3.3 cfs. Mill Creek sustains a minor trout fishery near its mouth. Chemically, its waters show no major differences from the other study streams. Turbidity and pH are slightly higher than other streams, but not high enough to classify them as being different. A large waste dump in the headwaters poses a continual pollution source.

METHODS

Most stations for benthic macroinvertebrate studies were randomly selected in riffle areas, located on aerial photographs, and marked on the ground with numbered metal stakes for identification. Two sample sites (stations 6 and 7) were subjectively selected on the Blackfoot River to determine influences from Angus Creek on the Blackfoot River.

Benthic collections were taken monthly from study sites in the upper Blackfoot River, Angus Creek, Kendall Creek, and Mill Creek during August, September, and November 1973 and October 1974. A third set of samples was taken from August through October of 1976 on Angus Creek, Blackfoot River, and on six sites on Diamond Creek. Basket samplers (fig. 2) were used at each station to provide a consistent sampling technique (Hilsenhoff 1969; Mason and others 1973). The 0.45 ft^2 (0.04 m^2) hardware cloth baskets (mesh size 0.50 inch [1.77 cm]) were filled with gravel (7 to 15 cm diameter) from the stream. Three baskets per station were placed in a line perpendicular to stream flow for a minimum of 30 days to allow invertebrate colonization.

Figure 2.--Basket sampler used to collect benthic invertebrates.

At the end of the colonization period, the baskets were lifted quickly from the stream bottom and placed in plastic bags. All invertebrates and detrital material were removed from the substrate by rinsing and brushing. The removed materials were concentrated by being strained through a 0.017-inch (0.43-cm) mesh screen. Anything that passed through the screen was discarded. The material was placed in labeled jars, preserved with 70 percent ethanol, and transported to the laboratory.

The samples were sorted to the lowest possible taxa, identified, and counted. In the case of large numbers of invertebrates, the samples were subsampled using the Waters (1969) system. Species diversity (heterogeneity) indices were based on the Shannon-Weaver information function (Shannon and Weaver 1964).

RESULTS

Benthic Distribution

A complete list of the 84 identifiable taxa of benthic invertebrates collected in the basket samplers during the study is presented in table 1. Seventy-four taxa were identified (genus and/or species). Species richness ranged from 18 at station 9.7 (Diamond Creek) to 68 at station 5 (Angus Creek). Angus Creek had a total of 82 taxa followed by the Blackfoot River with 72 taxa. All the stations on Diamond Creek had a low number of taxa (18 to 29). This probably is partially due to the fact that only 1 year (1976) of sampling was done instead of 2 or 3 years of sampling as in the other streams.

Among the major groups genera were evenly distributed at all 18 sample stations. The lack of Mollusca in the basket samplers from Diamond Creek was an exception. Extensive qualitative sampling located only one specimen (*Lymnaea* sp.) of this phylum in Diamond Creek.

Table 1 also lists the five most abundant organisms taken at each station. Of a possible 33 sets of samples, the Ephemeroptera genus *Baetis* was the most abundant taxon on 28 occasions. Another mayfly, *Ephemerella inermis* was also abundant being found in 12 sets. The most abundant stonefly, *Nemoura* (Plecoptera), was found in 16 sample sets. The midge family, Chironomidae, was found in 31 of the 33 sample sets. The others taxa of major abundance were *Simulium* (11), *Turbellaria* (10), *Optioservus* (8), *Limnephilus* (7), *Hydracarina* (7), and *Gammarus lacustris* (6).

Only six genera (*Alloperia*, *Baetis*, *Cinygmula*, *Ephemerella*, *Nemoura*, and *Simulium*) were found at all 18 stations. Well over half of the taxa (48) were collected at nine or more of the sample sites and had widespread distribution in the upper Blackfoot River basin.

In several instances an organism figured prominently at one station but not at another. *Alloperia* in Diamond Creek, *Capnia* in Angus Creek, and *Baetis* in Mill Creek are examples. Thus, while 80 percent or more of the organisms consisted of 21 taxa at all stations, the kinds of organisms varied markedly between stations and within streams.

Benthic Composition

The relative abundance of each major taxon from the 1976 samples is listed in table 2. No particular group consistently made up more than 10 percent of the number at any station. At nine stations, a single group, Ephemeroptera, nevertheless made up more than 40 percent of the community. Relative abundance of major taxa varied enormously among stations as would be expected from the scattered distributions of many of the invertebrates and from the varied taxa ranked among the five most abundant. Within specific streams most of the major taxa at each station were strikingly close in relative abundance. Angus Creek was an exception with the Amphipoda and Oligochaeta being abundant at stations 0.2 and 1. These species probably reflect the occurrence of a small in-stream reservoir immediately upstream.

Table 1.--*Macroinvertebrates collected in the Blackfoot River drainage. The five most abundant organisms for each year are identified with an (*)*

STREAM	Mill Creek				Kendall Creek				Diamond Creek						Blackfoot River						Angus Creek												
STATION NO.	18		17		16		15		14	13	11	10	9.7	9	7			6			5			4			2	1		0.2	0.1		
SAMPLE YEAR	74	73	74	73	74	73	74	73	76	76	76	76	76	76	76	74	73	76	74	73	76	74	73	76	74	73	76	74	73	76	76	74	73
EPHEMEROPTERA																																	
Ameletus sp.	x		x		x	x		x	x			x	x	x		x			x		x	x		x	x	x	x	x	x		x	x	
Baetis sp.	x	x	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	x	*	x	x
Cinygmula sp.	x	x	x	x	x	x	x	x	x	x	x	*	*	*	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		
Ephemerella aurivilli										x								x															
E. coloradensis	x		x		x	x	x	x	x	x	x	x			x			x			x	x		x	x			x			x		
E. doddsi	x		x	x	x	x		x			x							x				x						x					
E. grandis	x					x	x	x	x	x	x	x	x	x	*	x	x	*	x	x	x	x	x	*	x	x	x	x	x		x	x	x
E. inermis	x	x	x	x		x	x	x	x	*	*	x	x	*	*	*	*	*	*	*	*	*	*	x	x		x	x	x	x	x		
E. hecuba																			x														
E. tibialis									*	x	*	x	x	x				x															
Heptagenia sp.	x	x		x	x	x		x		x		x		x	x	x	x	x	x	x	x	x	x	x		x			x		x		x
Leptophlebia sp.																x			x		x		x	x			x						
Paraleptophlebia sp.	x	x	x	x	x	x	x							x	x	x	x	x	x	x	*	x	x	*	x	x	x	x	x	x	x	x	
Rithrogena sp.					x				*	*	x	x	*	x	x	x	x	x	x	x	x	x	x	x	x								
Tricorythodes minutus																	x		x	x	x	x	x										
HEMIPTERA																																	
Corixidae																	x					x								x			
Gerris sp.																																	
PLECOPTERA																																	
Allopera sp.	x	x	x	x	x	x		x	x	x	x	x	x	*	x	x	x	x	x	x	x	x	x	x	*	*	*	x	x	x	x		x
Brachyptera sp.	x	x	x	x	x							x		x					x		x	x					x			x			
Capnia sp.	x	x		x		x	x	x				x		x		x	x			x		x	x	x	x	*	x	x	x	x			
Hesperoperla pacifica	x	x	x		x		x		x	x	x		x	x	x	x	x	x	x	x		x	x	x								x	
Isogenoides sp.					x	x	x	x	x	x	x	x	x	x	x			x	x		x	x		x			x	x	x		x	x	
Isoperla sp.		x	x				x	x			x	x	x	x	x	x	x	x	x	x	x		x				x	x	x			x	x
Megarcys signata	x		x		x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	
Nemoura sp.	*	*	*	*	x	x	x	x	*	x	x	*	x	x	x	x	x	x	x		x	x	x	*	*	*	*	*	*	*	*	*	*
Paraleuctra sp.	x	x	x									x														x							
Pteronarcella badia		x	x	x													x		x					x									
Pteronarcys californica				x		x									x	x	x	x	x	x	x	x	x										
Skwala parallela	x		x		x	x	x	x	x	x					x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	*	x	
TRICHOPTERA																																	
Athripsodes sp.	x	x		x												x	x		x	x	x	x	x	x	x	x	x	x	x		x		x
Brachycentrus sp.					x						x				x	x	x	x	x	x	x	x	x										
Cheumatopsyche sp.			x			x		x				x			x	x	x	x	x	x	x	x	x	x	x				x	x	x		
Ecclisomyia sp.	x	x	x	x	x	x	x	x													x	x		x	x	x	x	x		x	x	x	x
Glossosoma sp.				x		x										x	x			x		x											x
Helicopsyche borealis																x	x	x	x	x	x	x	x	x					x				
Hesperophylax sp.		x							x	x	x	x	x	x			x				x	x				x	x	x		x	x	x	x
Hydroptilidae			x	x	x	x	x								x	x	x	x	x	x		x	x		x	x		x	x				
Hydropsyche sp.	x		x			x	x			x					x	x	x	x	x	x	*	*	*	x		x	x	x	x	x		x	
Lepidostoma sp.	x			x											x	x	x	x		x	x			x			x			x	x		
Limnephilus sp.	x		x		*	*	*	*	x		x	x			x	x			x		x	x		x	x	x	x	x	x	*	*	*	
Neothremma sp.			x		*	x	*	*									x			x		x					x			x			
Oligophlebodes sp.			x		x	x	x	x																x									
Radema sp.	x		x		*	*			x			x												x	x	x	x	x		x	x		
Rhyacophila sp.	x	x	x	x	x	x	x	x	x	x	x		x				x			x				x	x	x	x	x	x		x		x
Triaenodes sp.															x	x		x			x			x							x		
Wormaldia sp.			x	x												x		x	x		x	x	x	x	x	x		x					

Table 1. (Continued)

Mill Creek				Kendall Creek				Diamond Creek						Blackfoot River						Angus Creek													STREAM
18		17		16		15		14	13	11	10	9.7	9	7			6			5			4			2	1		0.2	0.1			STATION NO.
74	73	74	73	74	73	74	73	76	76	76	76	76	76	76	74	73	76	74	73	76	74	73	76	74	73	76	74	73	76	76	74	73	SAMPLE YEAR
*	*	*	*	*	*	X	X				X			X			X	X	X			X	*	X	X	*	*	*		X	X	X	TURBELLARIA
																																	MOLLUSCA
X	X	X	X	X		X									X			X		X	X	X											*Ferrissia* sp.
X	X	X	X	X	X	X	X							X	X	X	X	X	X	X	X												*Fluminicola* sp.
X						X													X		X	X					X				X	X	*Gyraulus* sp.
X				X		X									X	X		X	X		X	X		X			X				X	X	*Lymnaea* sp.
X	X		X	X		X										X		X	X	X	*	*	X	X	X	X	X	X	X	X	X	X	*Physa* sp.
X	X	X		X	X	X									X		X	X		X	X	X	X	X		X	X	X	X	X	X	X	*Pisidium* sp.
																																	OLIGOCHAETA
	X		X	X	X	X					X	X			X					X	X		X					X	X		X		Lumbriculidae
X		X		X		X					X	X				X	X	X	X		X	X	X	X	X	X	X	X	*	X	X	X	Tubificidae
																																	HIRUDINEA
X				X		X									X					X	X	X	X	X		X	X	X	X		X		*Glossiphonia* sp.
																																	ACARI
*	*	X	X	X	X	X	X	X	X	X	X		X	X	*	*	X	*	*	X	X	X	X	X	X	X	X	X	X	X	*	X	Hydracarina
																																	AMPHIPODA
					X	*	*								X	X			X		X				X	X	*	*	*	X	*	X	*Gammarus lacustris*
															X	X				X		X	X			X			X	X			*Hyalella azteca*
																																	MEGALOPTERA
					X																X											X	*Sialis* sp.
																																	COLEOPTERA
						X			X					X			X			X	X		X		X	X	X		X	X	X	X	*Agabus* sp.
		X	X			X			X	X	X		X	X			X			X	X	X	X			X	X		X	X	X	X	*Ametor scabrosus*
								X							X			X			X	X	X	X		X	X	X					*Erychius* sp.
X	X	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X		*Cleptelmis* sp.
X																					X			X									*Dubiraphia* sp.
							X								X	X			X	X	X	X			X		X	X					*Haliplus* sp.
X		X	X	X	X	X		X							X	X		X			X		X	X	X		X						*Heterlimnius corpolentus*
X		X	X															X			X	X	X	X			X						*Hydraena* sp.
*	*	*	*	X	X	X	X		X	X				X	*	*	X	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X	*Optioservus* sp.
		X													X	X								X			X						*Zaitzevia parvula*
																																	DIPTERA
		X			X									X	X	X	X	X	X		X		X	X	X				X				*Antocha* sp.
		X	X		X					X					X	X		X	X	X	X	X		X				X		X	X	X	*Atherix variegata*
X	X	X	X				X								X				X	X		X	X	X	X	X		X	X	X	X	X	Ceratopogonidae
*	*	*	*	X	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	X	*	*	*	*	*	*	*	*	*	Chironomidae
	X	X																					X		X	X	X	X	X	X	X	X	*Dixa* sp.
	X		X	X	X	X	X		X							X	X		X	X	X	X			X							X	Empididae
																			X													X	Ephydridae
		X									X												X				X		X	X		X	*Hexatoma* sp.
X						X	X				X									X	X	X	X			X	X	X	X	X	X	X	*Limnophora* sp.
								X							X								X					X	X		X		*Liriopa* sp.
			X		X																	X			X		X	X			X		*Pedicia* sp.
X	X	X	X	X	X	X	X															X	X	X	X	X	X	X	X	X	X		*Pericoma* sp.
X	X	X	X	X	X	X	X	X	*	*	*	*	X	*	X	X	*	X	X	X	X	X	X	*	*	X	X	X	X	*	*	*	*Simulium* sp.
X	X	X	X	X	X		X																X	X		X	X	X	X	X	X	X	Stratiomyiidae
	X	X	X	X	X	X	X	X					X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	*Tipula* sp.
49		54		54		50		25	24	23	29	18	21	56			58			68			67			43	57		42	55			TOTALS
65				61				46						72						82													STREAM TOTAL

Table 2.--*Percentage composition of the various benthic macroinvertebrate taxa distributed by station. Values are based on data from the summer and fall sampling series of 1976 unless otherwise identified. Values have been adjusted to the nearest 1 percent*

Taxon	Stream and stations: Diamond Creek						Kendall Creek		Angus Creek						Mill Creek		Blackfoot River	
	9	9.7	10	11	13	14	[1]15	[1]16	0.1	0.2	[1]1	2	4	5	[1]17	[1]18	7	6
Coleoptera	1	-	-	-	1	2	3	2	1	7	6	2	4	3	6	16	2	2
Diptera	15	22	43	12	40	30	16	6	61	13	17	50	6	37	13	15	25	25
Ephemeroptera	53	70	44	74	46	56	20	29	5	5	14	8	43	30	25	12	62	59
Mollusca	-	-	-	-	-	-	1	1	1	5	3	3	2	2	<1	<1	1	2
Plecoptera	27	6	9	10	10	9	5	7	23	8	18	10	18	2	25	27	6	7
Trichoptera	3	1	2	3	2	3	32	19	4	10	5	8	15	21	7	7	3	3
Turbellaria	-	-	<1	-	-	-	6	28	1	-	7	15	9	-	18	16	-	-
Miscellaneous[2]	<1	<1	2	1	<1	<1	17	8	4	[3]52	[4]30	4	3	5	6	7	1	99

[1]Based on 1974 samples.
[2]Acari, Amphipoda, Oligochaeta, Megaloptera, and Hemiptera.
[3]Mainly Oligochaeta.
[4]Mainly Amphipoda.

Benthic Standing Crops

As a stream flows through its drainage basin it usually increases in size. Up to a point, habitats and niches within the drainage system also increase. The link numbers (the numbers of the first order streams occurring upstream of each station) reflect an increase in drainage area and indicate the relative amount of tributary influence. These increases are reflected in higher standing crops of many species of aquatic animals and plants unless negative environmental stresses occur. The standing crop estimates based on the 1976 collections (fig. 3) show an increase in the downstream direction, with the exception of station 2 on Angus Creek, which had the lowest number of benthic animals at 4,100/m^2. This decrease is probably due to the stream environment at station 2. Angus Creek changed from a riffle habitat at the beginning of the study to a pond environment when beaver dammed the stream.

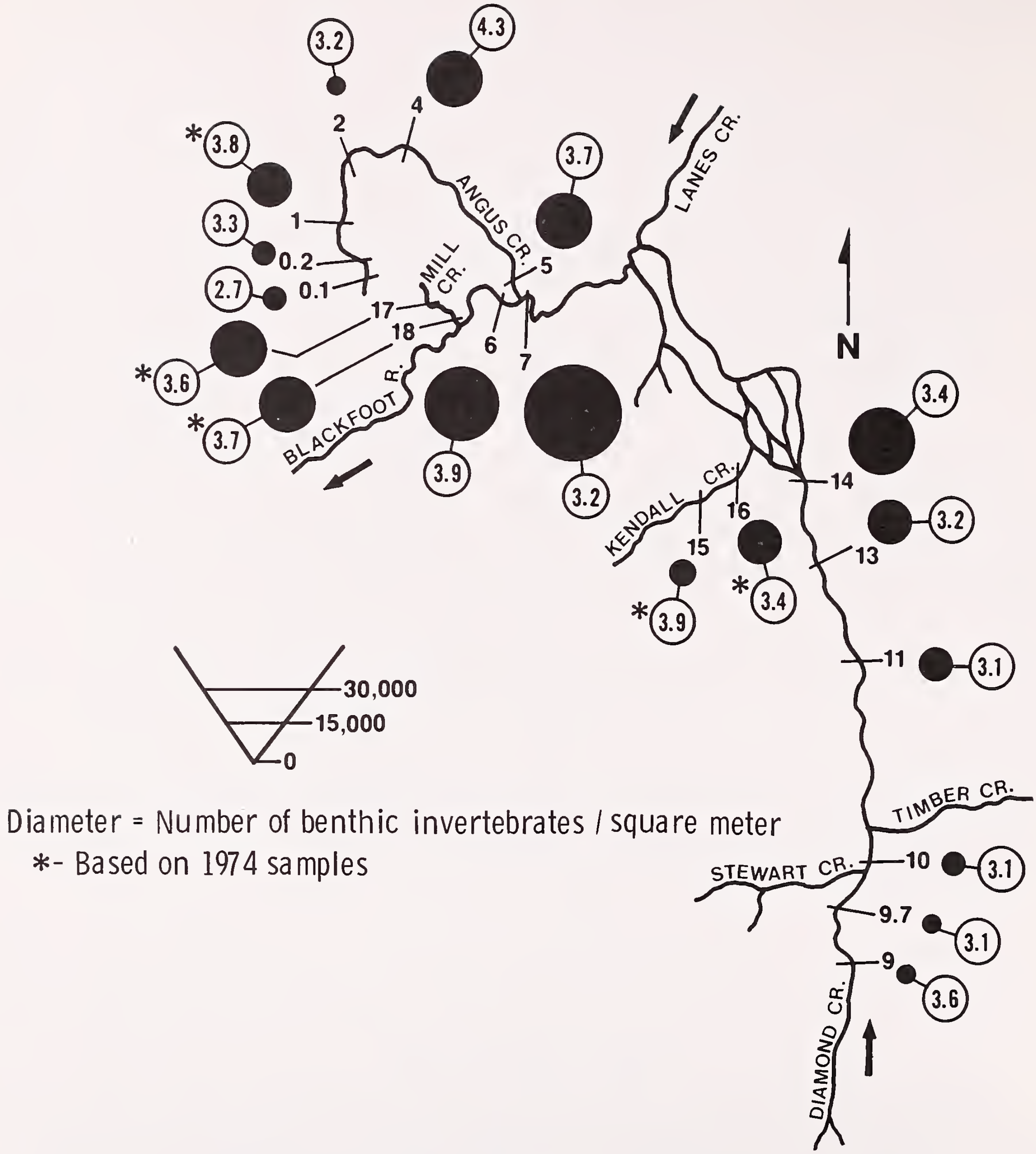

Figure 3.--Benthic macroinvertebrate standing crops and heterogeneity indices for fall samples, 1976.

Stations 6 and 7 on the Blackfoot River have the highest link numbers, 149 and 128, and reflect these in their size and large standing crops (table 3). There were, however, major decreases in benthic populations over time and in the number of taxa at stations 5, 6, and 7 near the mouth of Angus Creek (fig. 4). From 1973 to 1976, the benthic populations at station 7 on the Blackfoot River just above Angus Creek decreased from over 106,000/m^2 benthic invertebrates to fewer than 30,000/m^2. Stations 5 and 6 had similar decreases. The cause of these declines is unknown.

Table 3.--*Heterogeneity indices and standing crops of the benthic macrovertebrates of the upper Blackfoot River drainage. Blanks mean that no sample was collected*

Station		Heterogeneity indices			Number of taxa in analysis			Number/m^2		
		1973	1974	1976	1973	1974	1976	1973	1974	1976
Angus	0.1	2.7	3.3	2.7	36	40	40	8,475	9,211	7,683
Creek	0.2			3.3			42	--	--	4,946
	1	3.2	3.8		44	49		15,896	18,172	--
	2			3.2			45	--	--	4,106
	4	2.8	3.1	4.3	41	44	58	13,717	14,787	15,425
	5	3.6	4.1	3.7	50	64	52	30,585	21,480	15,906
Blackfoot	6	2.6	4.0	3.2	46	51	36	63,297	29,591	22,474
River	7	2.6	3.7	3.5	46	50	40	106,244	41,402	29,780
Diamond	9			3.6			21			4,356
Creek	9.7			3.1			18			4,608
	10			3.1			29			5,097
	11			3.1			23			7,259
	13			3.2			22			9,079
	14			3.4			26			13,598
Kendall	15	2.9	3.9		35	38		18,620	6,527	
Creek	16	3.3	3.4		42	40		15,280	11,906	
Mill	17	3.6	3.6		38	49		24,337	18,684	
Creek	18	3.6	3.7		36	40		12,969	17,100	

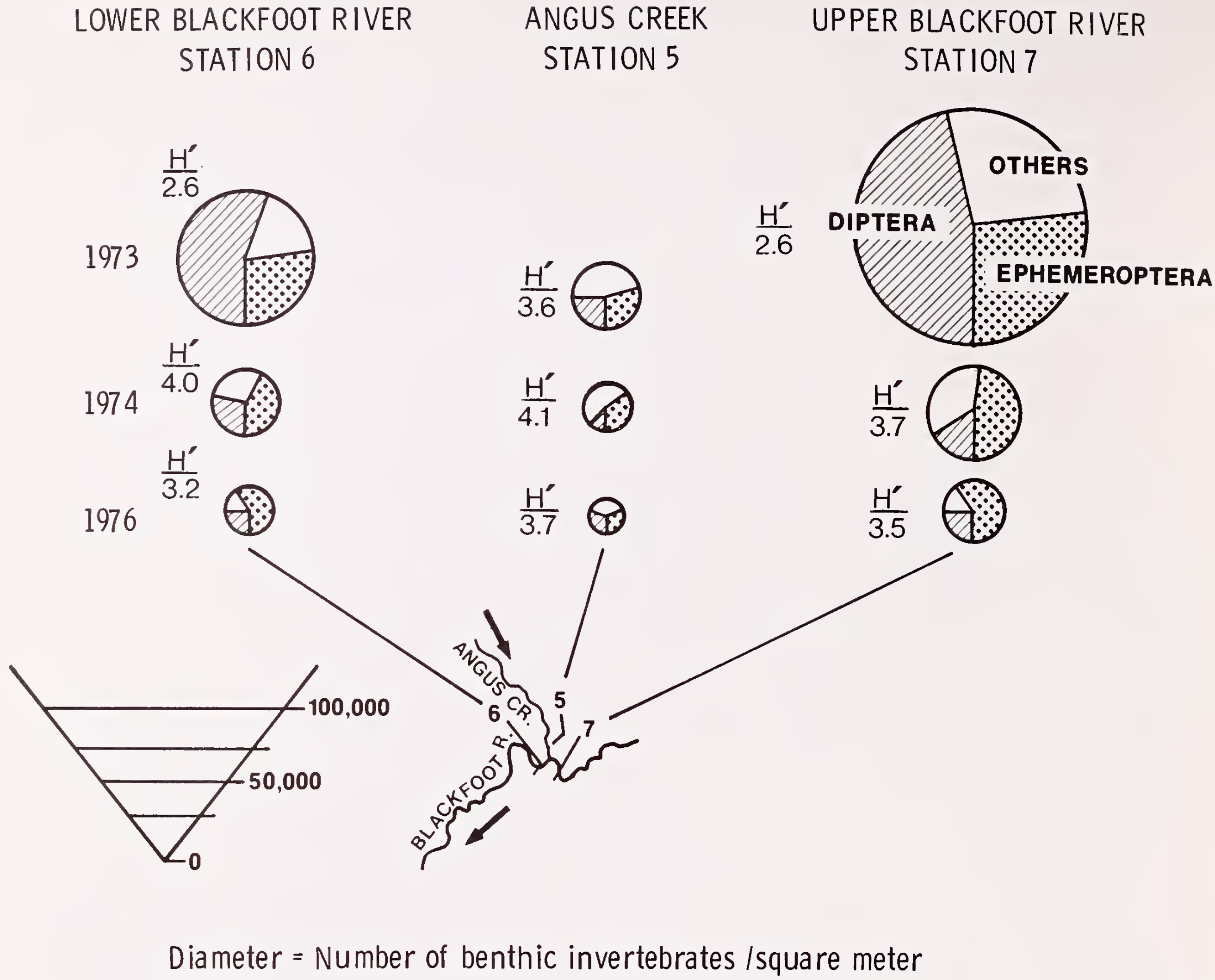

Figure 4.--Changes in benthic macroinvertebrates standing crops composition, and heterogeneity indices (H') at 3 selected stations (fall samples only).

Heterogeneity Indices

The makeup of the benthic macroinvertebrate community in a certain section of stream is a reflection of such factors as current velocity, channel substrate particle size, stream flow, water temperature, and food availability, as well as any abnormal environmental factors, such as silt, floods, and chemical and physical pollution that may influence the stream environment. Heterogeneity indices have been shown to be accurate indicators of adverse influences on stream ecosystems (Gislason 1971; Olive and Smith 1975); so indices differences occurring between sample stations and between stream communities can be used as indicators of environmental condition.

The Shannon-Weaver heterogeneity indices for all stations ranged from 2.6 to 4.3 with most values 3.1 or higher. The highest diversity values occurred in Angus Creek, the lowest in Blackfoot River.

A comparison of diversity indices at the upper Blackfoot stations can be made with published values. Wilhm (1970) furnishes a compilation of mean diversity indices for a variety of streams classified as clean, recovered, or polluted with various substances. In 21 streams listed as clean or recovered, mean diversity ranged from 2.6 to 4.6, whereas in 21 streams receiving pollution discharges, indices ranged from 0.4 to 1.6. The diversity indices for the Blackfoot streams fall well within the ranges of the clean or recovered streams.

DISCUSSION

Although benthic macroinvertebrate distributions in streams appear to be scattered and variable when collectively considered, more extensive sampling might reduce the number of discrepancies and reveal the presence of other invertebrates. The relative abundance of data will permit workers to measure changes in each stream's community composition.

Assessment of the general health of the upper Blackfoot River system can be made by comparing its community composition to those from other streams. Table 4 lists the number of discrete recognizable taxa in major classes and orders found in the Blackfoot system and several other southeastern Idaho streams. The Lost Rivers (Andrews and Minshall 1979) and Mink Creek (Newell and Shaw, unpublished [data on file at Idaho State University, Department of Biology]) receive minimal if any disturbance from human or agricultural sources. Although subject to an unknown degree of disturbance caused by livestock and irrigation, Deep Creek (Minshall and others 1973) is currently not considered seriously polluted, just intermittently disturbed. The upper and lower parts of the Portneuf River furnish an excellent contrast between healthy and degraded stream conditions (Minshall and Andrews 1973). The upper Portneuf is relatively undisturbed and supports a rich fauna. On the other hand, the lower Portneuf receives considerable amounts of sewage and toxic materials from urban, agricultural, and industrial sources and reductions in the biota parallel these additions. The total numbers of taxa ranged from 47 to 82 in the Blackfoot River and the tributaries studied. This range compares closely with the range of taxa (51 to 89) found in the relatively unpolluted streams listed. The total number of taxa in the lower Portneuf was 28, a considerable reduction from the upper Portneuf and considerably below the range for the Blackfoot streams, except Diamond Creek.

The range in numbers of taxa of Ephemeroptera (9 to 15), Plecoptera (10 to 12), and Trichoptera (7 to 17) in the Blackfoot streams compares very favorably with the same range of taxa in other southeastern Idaho streams (Ephemeroptera [5 to 20], Plecoptera [6 to 24], and Trichoptera [8 to 25]). These taxa are widely regarded as being highly sensitive to pollution. Comparable numbers of taxa in the lower Portneuf are Ephemeroptera 4, Plecoptera 1, and Trichoptera 3. The comparison indicates that the upper Blackfoot and its tributaries more closely resemble unpolluted streams of southeastern Idaho than polluted streams.

Table 4.--*The number of discrete, recognizable taxa of invertebrates in several southeastern Idaho streams is compared with the fauna of the upper Blackfoot River watershed*

Taxon	Diamond Creek	Kendall Creek	Angus Creek	Mill Creek	Blackfoot River	Lost River[1]	Mink Creek[2]	Deep Creek[3]	Upper Portneuf River[4]	Lower Portneuf River[4]
Acari	1	1	1	1	1	1	1	1	1	1
Amphipoda	--	1	2	--	2	2	1	2	2	2
Coleoptera	5	6	10	7	9	5	5	19	5	2
Diptera	8	11	15	13	9	6	12	11	5	4
Ephemeroptera	12	10	12	9	15	20	14	5	9	4
Hemiptera	--	--	2	--	1	--	--	5	1	--
Hirudinea	--	1	1	1	1	1	--	3	2	1
Lepidoptera	--	--	--	--	--	--	--	1	1	1
Lumbriculidae	1	1	1	1	1	--	--	1	--	--
Mollusca	--	6	6	6	6	3	4	7	6	4
Nematoda	--	--	--	--	--	--	--	1	1	--
Megaloptera	--	1	1	--	--	1	1	1	--	--
Odonata	--	--	--	--	--	--	--	5	2	3
Plecoptera	10	10	12	11	11	16	24	[5]1	6	1
Trichoptera	7	11	17	14	14	14	25	10	8	3
Tubificidae	1	1	1	1	1	--	1	1	1	1
Turbellaria	1	1	1	1	1	1	1	--	1	1
Totals	46	61	82	65	72	70	89	74	51	28

[1]Andrews and Minshall (1979).
[2]Newell and Shaw (unpublished) data at Idaho State University Department of Biological Sciences.
[3]Minshall and others (1973).
[4]Minshall and Andrews (1973).
[5]Only Plecoptera was collected.

A comparison of the macroinvertebrate fauna of the upper Blackfoot streams to that of streams polluted with organic and toxic wastes indicates gross dissimilarities. A septic zone fauna typical of streams polluted with organic sewage consists predominantly of oligochaetes, snails, rattail maggots, mosquitoes, and midge larvae. A recovery zone usually includes a lesser proportion of the septic zone forms and a larger proportion of blackfly larvae, mayfly nymphs, and caddis fly larvae (Gaufin and Tarzwell 1952; Gaufin 1956). Many of the typical recovery zone organisms were present in the Blackfoot River streams studied, but not in the abundance or relative percentages characteristic of organically degraded streams. A stream polluted with toxic inorganic wastes typically suffers a severe reduction in the number of species, sometimes to as few as eight or nine (Parsons 1960). Diamond Creek had from 18 to 29 taxa and could be characterized as depleted. The reason for this is unknown. The other streams had from 42 to 68 taxa and cannot be considered depleted in species.

The number and kinds of macroinvertebrate taxa and their distribution, the relative abundance of major taxonomic groups, the heterogenetic values, and the comparisons with other southeast Idaho streams indicate that the streams in the upper Blackfoot River generally are in a healthy condition. Stresses, however, appear to be present in the Diamond Creek drainage and the Lower Angus Creek area. The source of these is unknown at this time. Pollutants from mining, sediment from logging, and effects of livestock grazing are possibilities. Also, some of the stresses could be coming from natural causes. Biological observations will be needed to clear up questions arising from this study and to acquire a better set of temporal data to be used to determine if the system is changing and if so why.

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